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USSR Report

MATERIALS SCIENCE AND METALLURGY

No. 87

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UDC: 669.715.48.018

DENSITY AND SURFACE TENSION OF LIQUID ALUMINUM ALLOYS MADE OF RECYCLED RAW MATERIALS

Moscow TSVETNYYE METALLY in Russian No 10, Oct 82, pp 86-87

KISUN'KO, V. Z., BYCHKOV, Yu. B., BELOBORODOV, A. Z.

[Abstract] A study of the physical-chemical, casting and physical-mechanical properties of aluminum alloys made of secondary raw materials was performed. The experimental melts were produced under laboratory conditions and all alloying elements were present at either the minimum or maximum permissible levels according to state standard GOST 1583-73. As the concentration of the main components was increased to the maximum level the density of melts significantly increased. The surface tension decreases under these same conditions due to the increased concentration of magnesium. A diagram illustrates the change in density and surface tension of liquid aluminum alloys with temperature at the minimum and maximum constituent content levels. Figures 1; references 11: 9 Russian, 2 Western.
[26-6508]

UDC: 620.1:669.018.95

PRODUCTION AND PROPERTIES OF ALUMINUM-CORUNDUM COMPOSITE COATINGS

Moscow ZASHCHITA METALLOV in Russian Vol 18, No 5, Sep-Oct 82
(manuscript received 19 Sep 80) pp 792-795

SAYFULLIN, R. S., EKKERT, I. and BORTUNOV, N. V., Institute of Chemical Technology, imeni S. M. Kirov, Kazan, Technical University imeni K. Shorlemmer, Leina-Merseburg, East Germany

[Abstract] Al-Al_2O_3 composite electrochemical coatings were produced from a THF electrolyte modified by the addition of dispersed corundum particles. At a ratio of $AlCl_3$:$LiAlH_4$ of 3:1 or higher, bonding deteriorates and spottiness of the coating appears. The electroconductivity of the solution with an equimolar content of $AlCl_3$ and $LiAlH_4$ is 0.2-0.8 Sm/m at 25°C. The flash point of the bath is over 100°C. The voltage across the bath is 2.5 to 30 V with a distance between electrodes of 2 cm and a current density of 0.5 to 6.0 A/dm^2. The temperature is 30±10°C. The anode and cathode yields of 99.99% aluminum are near 100%. The precipitation rate at 1 A/dm^2 is about 12 μm/hr. The bath can produce composite electrochemical coatings of any thickness, operating for long periods of time without adjustment with near 100% yield at the electrodes. Thicker layers are rougher. With a thickness of 8-10 μm on steel the coatings are pore free. Figures 1; references 11: 4 Russian, 7 Western.
[17-6508]

UDC: 621.793:669.018.45

STRUCTURAL STUDIES OF COBALT-TUNGSTEN CARBIDE DETONATION COATINGS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, Oct 82
(manuscript received 30 Sep 81) pp 24-29

ALFINTSEVA, R. A., KADYROV, V. Kh., FEDORENKO, V. K. and SHARYPOV, A. Z., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] A study was made of the specifics of structure formation during detonation atomization of hard alloy mixtures such as VK-20 as well as the

mechanism of breakdown of the coating material in the process of vibration contact loading and fretting corrosion. The objects studied were two types of VK powders: one produced by the Moscow Hard Alloying Combine, one manufactured by mixing tungsten carbide powders. Type PK-1 cobalt powder was also studied. Structural and phase studies of the detonation coatings were performed by metallographic, qualitative and quantitative x-ray analysis and scanning electron microscopy. It was found that the phase composition of detonation coatings differed from the initial VK mixtures in that there was one-half or less the amount of WC as was in the initial metal tungsten and cobalt. The number and dimensions of tungsten carbide particles in the coatings are determined by particle size distribution of the atomized powder and the parameters of the detonation process. Five to 40 μm is the optimal powder particle size range. Most of the initial tungsten carbide is decomposed upon detonation to form intermetallides of tungsten with cobalt. Future studies should be directed toward increasing phase and structural homogeneity of the layers produced. Figures 3; references 13: 6 Russian, 7 Western.
[30-6508]

UDC: 620.197.3.621.357.7

STRUCTURE AND CORROSION-MECHANICAL PROPERTIES OF NICKEL-BORON COMPOSITE COATINGS

Moscow ZASHCHITA METALLOV in Russian Vol 18, No 5, Sep-Oct 82
(manuscript received 2 Nov 81, after revision 21 Jan 82) pp 719-724

KHALDEYEV, G. V., KOSKOV, V. D. and YAGODKINA, L. M., Perm State University imeni A. M. Gor'kiy; Perm Branch, All-Union Scientific Research Institute of Drilling Equipment

[Abstract] X-ray structural and electron microscope analysis were used to study the influence of electrolysis conditions, substrate heterogeneity and distribution of dispersed inclusions on the fine structure and corrosion-mechanical properties of composite nickel-boron electrochemical coatings. X-ray structural analysis was performed on a DRON-2.0 diffractomer in copper K_α radiation using the (111), (200), (220) and (311) reflexes. A neophot-2 instrument was used to study the distribution of boron inclusions through the cross section of the specimen. The studies revealed that the formation of the structure of composite coatings is influenced by the heterogeneity of the substrate and defect content of the surface transient layers. Dispersed inclusions of boron, serving as an effective barrier to the propagation of plastic deformation, increase the hardness and wear resistance, but somewhat decrease corrosion resistance of the composite coatings. Figures 4; references 10: all Russian.
[17-6508]

UDC: 620.194.3:621.891:621.762:678

STUDY OF VIBRATION RESISTANT COMPOSITES DESIGNED FOR DAMPERS

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 82
(manuscript received 4 Dec 81) pp 103-105

KARPINOS, D. M., TUCHINSKIY, L. I., STUPKO, A. V., VISHNYAKOV, L. R. and ASKOCHENSKIY, Yu. B., Institute of Material Science Problems, Ukrainian Academy of Sciences, Kiev

[Abstract] New wear resistant and vibration resistant friction materials are described, intended for the manufacture of damping devices. Shock absorbers with friction elements made of the new materials are also diagrammed and described. Two groups of composite materials were tested, based on modified phenol-formaldehyde oligomer filled with metal powder plus thermo-plastic polymer, either modified or nonmodified by the addition of aluminum oxide. Analysis of the experimental data showed that the addition of the aluminum oxide, while not increasing wear resistance, did increase the force of friction and thus avoid resonant phenomena in shock absorbing units. The new composites, called FSF-1A, are superior in wear resistance to KF-3G asbestors fiber material, and the coefficient of friction, 0.24 to 0.26, allows friction damping of vibration loads, The aluminum-oxide modified composites can be used successfully in shoch absorbers subjected to loads in three dimensions. Figures 3; references 5: all Russian.
[14-6508]

UDC 621.74.046:539.375.6

INFLUENCE OF STRUCTURE ON STRENGTH OF ALUMINUM-CARBON STRIP FIBER COMPOSITE MATERIAL

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 10, Oct 82 pp 51-54

CHERNYSHOVA, T. A., KOBELEVA, L. I. and USTINOV, L. M., Institute of Metallurgy imeni A. A. Baykov

[Abstract] Results are presented from studies of the variation in strength of composite materials as a function of the structure of the components

(nature of spinning of carbon strip) and quantity of carbide phase formed upon manufacture. Fibrous composite materials made of aluminum and carbon were produced by liquid phase saturation of the carbon strip with AL2 silumin at 630 to 670°C. The strength of the LUZ strip filaments was 2600 MPa, the modulus of normal elasticity 26,700 MPa. Increasing the temperature and time of saturation of fibers casued an increase in the quantity of carbide phase and an irregular variation in composite strength with a maximum at a concentration of 13.8 mg Al_4C_3 per gram of carbon. Figures 4; references 7: 4 Russian, 3 Western.
[23-6508]

UDC: 621.791:061.3

8TH NATIONAL CONFERENCE ON WELDING OF DISSIMILAR COMPOSITE AND MULTILAYER MATERIALS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 82 pp 41-42

KIRPATYY, V. A., engineer

[Abstract] On 16-19 February 1982 the Ye. O. Paton Institute of Electric Welding hosted the conference involving 300 specialists from 68 cities. Academician B. Ye. Paton opened the conference by emphasizing that the welding of dissimilar metals is a pressing problem of the day in many branches of industry. Subjects discussed included: problems of welding of dissimilar materials; the scientific principles and technologies of welding by rolling, pressing and diffusion; theoretical problems of the production of multilayer sheets; explosive welding of dissimilar materials; heat and pressure welding in the manufacture of bimetallic pipe and fittings; welding of titanium to steel; the influence of gases such as nitrogen, oxygen and hydrogen and elements such as P, C, Fe, S and O on the formation of pores and crystallization cracks in welding of steel and monel; the influence of welding methods and materials on the quality of joints between copper and various steels; aluminum cladding by melting; pulsed electromagnetic fields in the welding of metals by plastic deformation; and welding of niobium with steel using a defocused beam.
[25-6508]

UDC: 621.791.061.3

10TH NATIONAL SCIENTIFIC AND TECHNICAL CONFERENCE ON DIFFUSION JOINING OF METALLIC AND NONMETALLIC MATERIALS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 82 p 40

TRIFONOVA, N. A. and TIKHONOVA, I. S., engineers

[Abstract] This conference was held 13-14 May 1982 in Moscow and involved the participation of scientific organizations, leading universities of the

nation and industrial enterprises and ministries. The work of the conference was conducted at two plenary sessions and 5 specialized sections, and 98 reports were heard. Subjects discussed included the current status and problems of diffusion joining (welding) of materials; problems of diffusion welding of precision parts of homogeneous materials and alloys; results of studies of diffusion joining of materials with glass, ceramics, ferrites and metals with metals through oxide layers; diffusion welding of aluminum alloys and finishing of the surfaces of composite materials after diffusion welding; quality control of diffusion welding; studies of the mechanical properties of titanium alloys following diffusion welding; diffusion welding of molybdenum crystals; corrosion resistance of diffusion welded joints in aqueous media; and equipment used for diffusion welding. The increased use of diffusion welding throughout the nation was noted. Recommendations were adopted determining the main paths for effective development and use of diffusion welding in the reinforcement of the operating elements of separator and shape changing stamps, manufacture of bimetallic punches for stamping of fluidics equipment, cutting bimetallic tools, quartz optical and measurement elements, structures of heat resistant steels and alloys, electric vacuum instruments, semiconductor crystals joined with metals and alloys and the production of composite materials. Particular attention must be given to the planning and manufacture of experimental and industrial models of welding equipment.
[25-6508]

UDC: 669.052

KAZAKHSTAN NONFERROUS METALLURGY DEVELOPMENT PROSPECTS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 5, Sep-Oct 82 (manuscript received 17 May 82) pp 7-12

[Article by A. M. Kunayev, Alma-Ata: "Combined Processing of Raw Materials and Development Prospects of Kazakhstan's Nonferrous Metallurgy"]

[Text] The problem of combined utilization of raw materials is not a new one for Kazakhstan's metallurgists -- scientists and production people: almost all the ore bodies in this republic contain complex ores, and the majority of minor and rare metals are recovered as by-products in lead, zinc, or copper production operations. We have somewhat unthinkingly become accustomed to speaking about inexhaustible reserves of mineral resources in our country. Unfortunately that is not quite accurate. Mineral raw material resources are indeed enormous, but deposits of high-grade ore at depths permitting profitable extraction are being intensively exploited, while growing production volumes are making losses of raw materials increasingly more intolerable. There is also another aspect -- commercial-value waste products are contaminating the environment, occupy substantial land acreages, and even require the provision of special, costly disposal burial. This is why the development and utilization of no-waste industrial processes should be viewed as a basic policy in development of our nation's economy.

Principal scientific and scientific-technical activities by the KaSSR Academy of Sciences in the area of nonferrous metallurgy are directed toward elaboration of the theoretical principles and technologies of advanced processes of combined utilization of crude ore at all stages of its mining and processing, which provide an increase in production of nonferrous and rare metals and improved efficiency of societal production. The workforces of a number of the Academy's scientific establishments are working on accomplishing this important task for our nation's economy, taking into account today's demands regarding efficient exploitation of natural resources and environmental protection.

Scientists in the field of mining have performed a number of studies, resulting in the capability substantially to reduce losses of valuable minerals in the ground and to extend the productive life of ore bodies. Decrease in the "waste" content of metal in the ore constitutes an important reserve potential for

expanding the raw materials base of nonferrous metallurgy and efficient utilization of mineral reserves. At the mines at the Dzhezkazgan ore deposit, for example, ore reserves in this deposit increase by 40 percent with a 0.1 percent decrease in the waste content of copper in the ore, while metal reserves increase by 22 percent. A 0.1 percent decrease in the waste content of copper makes it possible to expand Dzhezkazgan's raw mineral resources and bring low-grade ores into production. A reestimate of the off-balance-sheet ore reserves of the Belogorskiy Combine's Ognevskiy mine indicated the advisability of their joint exploitation with on-balance-sheet reserves, which makes it possible to achieve more complete ore removal and extend the ore body's productive life.

In recent years the most significant work, resulting not simply in improving but in accomplishing thorough reorganization, is being done in the area of copper metallurgy. Of primary significance here are autogenous processes of smelting sulfide ores and concentrates, which make it possible substantially to reduce energy expenditures and efficiently to resolve problems of salvaging raw materials and waste gases, recovering associated elements, and problems of environmental protection. Selection of an optimal process technology and design of metallurgical equipment for autogenous smelting is determined by the physicochemical laws governing the processes of high-temperature oxidation of metal sulfides, by the distinctive features of reaction and separation of sulfide-metallic, oxide and gaseous phases, by the conditions of mass transfer and heat exchange in the reaction zone, etc. Considerable attention is being devoted at the KaSSR Academy of Sciences' Institute of Metallurgy and Beneficiation to theoretical validation of the processes of autogenous smelting of sulfide copper, lead, and zinc containing concentrates. Scientists are studying the kinetics and chemism of oxidation of sulfides of iron, copper, lead, zinc, cadmium, and rhenium in relation to process temperature, composition of interacting phases and the conditions of their contact, are investigating the thermodynamics of multiconstituent sulfide-oxide systems, and are performing mathematical modeling of the processes of oxidation of sulfide materials. Research results are helping determine an optimal autogenous smelting process for sulfide concentrates of various composition. An advanced oxygen-suspended cyclone-electrothermal (KIVTsET) method of autogenous smelting has been proposed and adopted for processing copper-zinc concentrates; this method makes it possible in a single piece of metallurgical equipment to extract copper into matte, zinc into sublimates, and sulfur into sulfuric acid via sulfur dioxide.

The institute, jointly with scientists at the Moscow Steel and Alloys Institute, has developed and tested on an experimental commercial scale an intensive process, for processing copper ore, of smelting into high-grade matte in a "liquid bath" (PZhV). The decision has been made to build an experimental commercial-size large-capacity PZhV installation.

An additional step in the development of autogenous process technology is the smelting of copper concentrates into white metal or directly into blister copper and calcium slags suitable for producing slag wool, castings, and slag pyroceramics. This method, developed on a larger scale, offers a realistic possibility of solving the problem of developing a no-waste technology for processing copper concentrates.

A process arrangement for an improved electrothermal method of treating low-sulfur high-alumina copper concentrates and conversion of copper mattes was developed on the basis of study of the physicochemical properties of products and the thermodynamics of matte-slag systems, taking into consideration gaseous phase composition, and tested under commercial conditions at the Dzhezkazgan Mining and Metallurgical Combine. Tests performing conversion of copper mattes at the Dzhezkazgan Mining and Metallurgical Combine, employing as flux liquid waste slag from electric furnace smelting of copper concentrates, indicated that this results in a substantial reduction in quantity of fluxes and slag yield, while this in turn leads to reduced losses of copper and other metals with waste slags and stabilization of process equipment operation. The new process consists essentially in smelting pelletized copper concentrates with limestone and circulating, pre-reduced converter slag into copper-rich metallized matte (60-65 percent Cu) and high-calcium, siliceous, low-iron waste slag, part of which is utilized directly in liquid form as a flux in matte conversion, while the remainder is used in making building materials. Investigations conducted at the Karsakpay Plant indicated that slags of this composition can be directly utilized for making mineral wool and castings.

Considerable attention is being focused on the problem of processing slags. The fact is that production of the majority of nonferrous metals involves the separation of gangue and the iron of sulfide concentrates in the form of metallurgical slags, the metals content in which is in many cases higher than that in mined ores. The bulk of the old slag piles and currently-produced slags are not presently being utilized, while processing a portion of slags by fuming-process and Waelz-process methods does not ensure total utilization of all slag constituents.

A so-called carbide-thermal method of depleting slags has been developed and tested, consisting essentially in reducing slag melts with a mixture of lime and coke in an electric furnace, where calcium carbide forms and reacts with the oxidized metal compounds. This method achieves deep nonferrous metals depletion of slags and utilization of the silicate portion for the building materials industry.

In the field of lead metallurgy, theoretical studies and tests have been conducted on shaft-furnace lead smelting with employment of heated-air blast, oxygen-enriched blast, and natural gas. Tests have shown a substantial increase in the specific throughput capacity of shaft furnaces, decreased consumption of air and short-supply coke, and reduced emissions of particulates and carbon-containing gases.

Formulation of the theoretical principles and methods of comprehensive utilization of complex ore and the intermediate products of lead production has made it possible to create a new and progressive area -- metallurgy of the thiosalts of nonferrous metals. Practical implementation of a method of processing lead production intermediate products has made it possible to increase the direct recovery of metallic lead, copper in the form of copper compounds, cadmium in sublimates, and zinc in concentrate. This method was also employed to process secondary lead with excellent specification figures: an increase in direct recovery of lead and antimony in the form of battery

alloy, improved trapping of particulates, as well as other improved indices in comparison with shaft-furnace smelting.

Research in the area of vacuum metallurgy is of considerable interest. Processes have been developed for treating complex mercury-antimony, gold-arsenic, and gold-antimony ore and concentrates. Essential for practical implementation of the above-enumerated processes is more effective participation by organizations of the USSR Ministry of Nonferrous Metallurgy in the business of designing and building vacuum processing equipment. Particularly promising are vacuum processes for refining metals. World renown has been won by a process and equipment for vacuum refining tin, for which five licensing agreements and contracts have been signed. Adoption of this process at the Novosibirsk Tin Combine makes it possible not only to produce high-grade tin with a high percentage of recovery, but also to obtain considerable quantities of impurity metals in the form of merchantable product.

The KaSSR Academy of Sciences' Institute of Organic Catalysis and Electrochemistry is also developing another method of refining metals -- an amalgam technique. When employing mercury and amalgam electrodes in a layout for combined hydrometallurgical processing of complex ores, amalgamation and electrochemical methods are employed, which include electrolysis with a mercury cathode and cementation by amalgams. These methods make it possible to perform combined recovery of thallium and indium from complex ore products, with subsequent separation in the form of highly-pure metal.

The depletion of high-grade ore bodies is forcing us to mine ores with low metal content. In the last 10 years, for example, the content of lead in ores at Kazakhstan's mining enterprises has declined by 29 percent, zinc by 47 percent, and copper by 17 percent. It is becoming particularly important under these conditions to develop and utilize geotechnology processes, which include recovery of nonferrous metals from off-balance-sheet and wasted ores by methods of dump leaching and underground leaching.

Institutes of the KaSSR Academy of Sciences have developed and tested on an experimental-commercial scale on a percolation unit at the Tekeliy Lead and Zinc Combine a procedure of selective leaching of lead and zinc. In the first stage lead is leached out by solutions of ferric chloride in the presence of sodium chloride, and in the second stage the zinc is put into solution by solutions of sulfuric acid. Lead is separated out of the solutions into a merchantable product by contact deposition on iron, and zinc -- by sodium carbonate precipitation. Cadmium and silver are recovered in addition to the principal metals. Presently being considered is location and setup of an underground leaching operation. A felicitous example of a combined approach to solving the problem is a series of studies aimed at developing a process of leaching copper ore in the oxidized zone of the Aktogay ore body. Leaching of copper is done with sulfuric acid solutions. Laboratory investigations and experimental-commercial-scale tests have shown that these ores are a favorable object for dump-leaching. In conformity with materials submitted to the State Commission on Mineral Resources, oxidized ores of the Aktogay deposit were assigned to the category of balance-sheet resources, as a result of which total copper reserves of this ore body increased substantially.

We should note that underground and dump leaching of ores is accompanied by significant social effect. Working conditions for mine workers become easier and less hazardous, there is no need to assign large acreages of land to mining enterprises, the natural landscape is not disrupted, and the environment is protected against pollution by industrial waste. The scale of research being conducted, however, in view of the importance of the problem, is currently inadequate. Factors delaying comprehensive study, development and adoption of methods of dump and underground leaching include weak development of basic research. For example, there are no theoretically formulated technical or economic criteria for organizing leaching processes at mineral deposits. Specific hydrogeological studies were not performed at a single one of the leaching sites (with the exception of Tekeli), although the need for such investigations is obvious, for studying and preventing the migration of solutions in unwanted directions. It is necessary to conduct extensive physicochemical investigations on the selective recovery of metals from low-concentration solutions of complex composition produced during underground and dump leaching.

Our country's aluminum industry is one of the world's leaders in level of technology and scale of production. Alumina production is the most complex element of the aluminum industry. Therefore aluminum industry development prospects are organically and inseparably linked with the production of alumina.

The Institute of Metallurgy and Beneficiation has conducted an extensive group of research studies to investigate structural and phase transformations in multiconstituent alumina-containing systems. New methods of intensifying alumina technology processes have been scientifically validated, and unique engineering solutions have been devised for combined processing of high-silicon alumina-containing raw materials: the Bayer hydrochemical process, a method of processing high-silicon bauxites into alumina, crude iron and cement, a method of combined processing of red muds and nephelines, upgrading low-grade bauxites by the magnetization roasting method, etc.

The Pavlodar Aluminum Plant is the first in the Soviet aluminum industry to install a sequential combined Bayer-process calcining setup for processing low-grade Kazakhstan high-silicon bauxites. Adoption of the new technology, together with equipment design and layout, has produced a maximum level of recovery of the principal constituent -- alumina, minimal caustic soda losses, and full utilization of raw material. Today 97 percent of the alumina produced at the plant bears the state Seal of Quality, while the so-called waste residue is used in part in the production of building materials and in the future is slated for complete utilization as a backfill material for mine workings.

The theoretical principles of the technology of combined processing of alumina-containing raw material for the purpose of recovering valuable associated elements have been formulated. Scientists at the Institute of Metallurgy and Beneficiation have investigated and proposed a fundamentally new method of extracting gallium and other elements from aluminate solutions, which formed the basis for development of a new area of electrohydrometallurgy -- gallamic metallurgy. The method is based on reduction of ions of various metals in

aqueous solutions by gallium-based liquid alloys. Scientists established the mechanisms of reaction between aluminum (gallama) with ions of gallium, vanadium, zinc, lead, copper, molybdenum, arsenic, chromium, various forms of sulfur, and organic substances in caustic solutions. They studied the kinetics of reduction of gallium ions and ionization of aluminum from concentrated and dilute aluminate-gallate solutions by (gallamami) with a broad range of aluminum content in them, the phenomenon of metal formation during cementation, plus other processes.

Basic research to validate the processes of separating out compounds of vanadium, phosphorus, fluorine and rubidium from alumina-containing raw material has been conducted in order to solve the problem of combined recovery of other valuable constituents.

The theoretical research which had been performed made it possible to devise new process setups for the by-product recovery of the above-enumerated elements from aluminate solutions. Large-tonnage gallium metallurgy was created in the USSR. This became feasible thanks to the versatile possibilities of the new gallamic method of extracting gallium from solutions of practically any composition in combination with the simplicity of the equipment employed in the process and elimination of the need to concentrate the gallium in solution. The uniqueness of this process for obtaining gallium resulted in its patenting in a number of foreign countries and in licensing agreements with Hungary and the GDR. A process for obtaining vanadium pentoxide was also adopted into commercial production. Processes for obtaining compounds of fluorine, phosphorus, and rubidium have been tested and recommended for adoption.

Intensive exploitation of the Ekibastuz coalfield and construction of a number of large-capacity heat and electric power plants, which eject each year tens of millions of tons of ash, present the problem of combating environmental pollution, disturbance of the ecological balance, and worsening of sanitation and health conditions. In order to solve this problem, research is being conducted on recovering fly ash to use in producing alumina, cement, and chemical products.

Considerable research has been conducted in the area of metallurgy of rare and alloying metals, which has made it possible to adopt a process of ion-exchange recovery of rhenium from intermediate products of lead production, and the extraction method of obtaining chemically pure vanadium pentoxide from intermediate products of titanium-magnesium production. The technology has been devised and a preliminary design ordered for construction of a shop for recovering vanadium from spent catalysts, and commercial-scale tests have been conducted on replacing production of calcium molybdate with molybdenum trioxide and extraction of tantalum and niobium from chloride sublimates of titanium production.

There is presently a realistic possibility of achieving substantial production expansion and construction of new facilities for producing alloying metals. The fact is that quite a few deposits of rare-metal ores have been designated zabalansovyy [not included in reserves of commercially-minable minerals] due to the low content and fine dispersion of valuable constituents. As a rule these

ores are complex -- high-silicon, containing phosphorus, sulfur, arsenic and carbon; their utilization will be economically feasible under the condition of comprehensive processing, whereby all principal components -- phosphorus, silicon, carbon, and other elements -- are utilized in addition to the rare metals. Many years of basic research have made it possible to validate and devise a process of combined processing of high-silicon ores of rare metals together with phosphorites in the production of elemental phosophorus. The principal components of the ore -- silica -- is utilized, with by-product recovery of rare metals. The rapidly growing phosphorus industry requires hundreds of millions of tons of quartzite flux. Their replacement of silicide ores of rare metals makes it possible not only to expand the raw materials base of the phosphorus industry but also to concentrate rare metals in ferrophosphorus. The presence in ferrophosphorus of such valuable elements as vanadium, manganese, molybdenum, and others substantially increases possibilities for its profitable processing. For example, the first thousand tons of low-alloy ferrophosphorus produced was used at enterprises of the Ministry of Railways as a combined hardener in the manufacture of brake shoes with a savings of more than 1 million rubles. A decision was adopted to set up experimental vanadium production with the combined processing of Karatau vanadium quartzites and phosphorites.

Research being conducted in several areas at the KaSSR Academy of Sciences Chemical-Metallurgical Institute is of interest. One project proposes extracting a most common impurity -- pyrite -- from complex-composition polymetallic concentrates by means of pyrrhotitizing roasting with subsequent magnetic separation of pyrrhotite. Thus the basic problem of combined utilization of such a raw material is solved even prior to hydro- or pyrometallurgical processing of the entire mass of concentrates, namely -- separation of iron from nonferrous and rare metals. In addition, following pyrrhotitizing roasting and magnetic separation, one can return to conventional beneficiation methods of selective recovery of remaining valuable constituents, since the attachments between minerals are destroyed in roasting. This method has been tested on molybdenum, tungsten, copper-zinc and other concentrates.

Another area of research involves preliminary removal from concentrates of an impurity which is just as common as pyrite -- silicon dioxide. This is achieved by autoclave caustic-soda treatment in a nonoxidizing environment. The bulk of the silicon dioxide goes into solution, which is subsequently recovered as a pure silicon-containing product which is used as a raw material for producing cement of the very highest grades, with simultaneous recovery of the caustic soda. With this method it is possible to copper- and sulfur-enrich sulfide concentrates to such a degree that it is no longer necessary to perform subsequent reverberatory or electric furnace smelting into large quantities of waste slag, and one can employ the most modern smelting processes, in particular autogenous smelting of concentrates, totally eliminating utilization of additional energy.

Principal tasks for the immediate future also involve further development of a combined raw materials processing arrangement at the stage of beneficiation and metallurgical production. Considerable attention must be focused on research in the area of mineral beneficiation. An analysis of losses of valuable components in mining and processing complex ores indicates that if a

value of 100 percent is assigned to all losses, approximately 15 percent of losses of principal metals occurs in metallurgical processing, approximately 25 percent is lost in mining, and up to 50 percent in the process of beneficiation. Consequently development and adoption of fundamentally new as well as improvement of existing beneficiation processes and equipment constitute an important reserve potential for increasing recovery of metals and comprehensiveness of utilization of raw materials.

In the metallurgical industry efforts should be concentrated on developing and adopting waste-free technologies. In solving the problem of utilizing nonferrous metallurgical industry slags, it is essential first of all to organize processing of current slags, in order to prevent further growth of slag piles and to save energy on their subsequent melting. The matter of waste treatment and processing should be handled in a centralized manner: waste from nonferrous metallurgical and chemical industry enterprises can be raw materials for ferrous metallurgy or vice versa, etc.

Conclusion. Development of a scientifically validated technology of comprehensive and efficient processing of mineral raw materials and its practical adoption constitute tasks of great national importance. The principal efforts of Kazakhstan's scientists and specialists working in the field of nonferrous metallurgy will be directed toward solving these problems, in combination with developing no-waste metallurgical processes.

3024
CSO: 1842/13

UDC: 669.243.88

EXPERIENCE IN HEATING OF ELECTRIC FURNACES AT THE NADEZHDA METALLURGICAL PLANT WITH NATURAL GAS

Moscow TSVETNYYE METALLY in Russian No 10, Oct 82 pp 21-22

GULEVICH, A. G., SOKOLOV, L. I., STEPANOV, Ye. N., VOSTRIKOV, G. V. and RYABKO, A. G.

[Abstract] The 12.36-m-diameter circular 3-electrode 18 kVA electric furnaces, lined with magnesite and chrome-magnesite brick with the suspended arch sealed with corundum-based brick, are preheated with natural gas using 5 burners. The lining temperature is monitored by seven thermocouples. The shell water cooling system is actuated on the third day of heating when the shell temperature reaches 130°C (water consumption 140 cubic meters per hour). The furnace itself is started up on the 13th day of heating, when the inside temperature has reached 570-610°C and the shell has "grown" by 20 to 24 mm in radius, after 200 tons of solid slag are loaded into the furnace (over the course of a day). The use of natural gas assures uniform heating of the furnace liner and allows flexible regulation of the process. Figures 1.
[26-6508]

UDC: 621.763:620.178:669.721

INFLUENCE OF CERTAIN FORCE FACTORS ON RIGIDITY CHARACTERISTICS OF MAGNESIUM-BORON FIBER COMPOSITE MATERIAL

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 82
(manuscript received 3 Jul 81) pp 39-42

VOYTENKO, A. F., SAMARIN, V. K. and GORDIYENKO, A. I., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] Composites consisting of a metal matrix reinforced with boron fibers have been widely used as structural materials in recent years. Calculation of the rigidity characteristics such as modulus of elasticity of fiber composites can be performed by using the additive nature of the variation in modulus of elasticity as a function of volumetric content of the components. However, fiber materials have great anisotropy of mechanical properties and therefore differ from a simple mechanical mixture. Therefore studies of the influence of certain force factors on the elastic properties of fiber composites is of great practical interest. Even simple composites are structural elements with very heterogeneous distribution of stresses within the volume of the material. These factors require experimental determination of the modulus of elasticity of reinforced composite materials in cyclical fatigue testing. The change in rigidity of the material during the process of cyclical loading must be considered in estimating the reliability and durability of reinforced structural composites; otherwise, artificially elevated results will be obtained. Figures 1; references 7: all Russian.
[15-6508]

UDC: 621.763:621.762.5:620.178

STRUCTURE AND PROPERTIES OF PERMEABLE THIN FIBER MATERIALS PRODUCED FROM POWDERS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 82
(manuscript received 15 Apr 82) pp 42-45

FEDORCHENKO, I. M., KOSTORNOV, A. G., KIRICHENKO, O. V. and GUZHVA, N. S., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] A study is made of the influence of the basic characteristics of thin fiber materials on their hydraulic and mechanical properties. The properties of permeable materials vary directly on their structural parameters such as porosity, pore size and geometric shape of pore channels. Thin fiber materials, with porosities of 90% or more, have high permeability, directly proportional to porosity. Thin fiber materials produced from powders have smaller maximum pore diameter with identical porosity. These materials can be classified as a new type of permeable material with properties inherent both in powders and in fibrous permeable materials. Figures 5; references 4: all Russian.
[15-6508]

UDC: 621.762

GAS STATIC FORMATION OF PARTS OF HEAT RESISTANT NICKEL ALLOY

Kiev POROSHKOVAYA METALLURGIYA in Russian No 9, Sep 82
(manuscript received 17 Jun 82) pp 75-78

ORLOV, V. K., MUKHAMETKULOV, M. A., KRATT, Ye. P., KOSIN, V. I. and KOSTYUKOV, V. I., All-Union Institute of Light Alloys

[Abstract] A study was made of the change in density and temperature conductivity of spherical EP-741P alloy powders upon gas static formation in sealed capsules. The experiments used steel capsules 90 to 505 mm in diameter and 180 to 300 mm in height. The capsules were equipped with thermocouples, filled with granules 70 to 300 micrometers in diameter, compacted by vibration, degassed, sealed and heated in a gas stat. When the temperature at the center reached 800, 900 or 1050°C, heating was stopped. Specimens were cut and density determined by hydrostatic weighing. The experiments make it possible to determine the mean temperature conductivity of the powder mass required to calculate the process of heating, as well as its variation with temperature. A simple equation is derived which can be used to calculate the heating of the capsules to 950°C. Figures 3; references 4: all Russian.
[15-6508]

UDC: 621.763:620.178:669.721

CYCLIC STRENGTH OF REINFORCED MAGNESIUM-BASED COMPOSITES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 10, Oct 82
(manuscript received 3 Jul 81) pp 66-70

KARPINOS, D. M., GORDIYENKO, A. I., SAMARIN, V. K., KADYROV, V. Kh. and VOYTENKO, A. F., Institute of Material Science Problems, Ukrainian Academy of Sciences; Institute of Strength Problems, Ukrainian Academy of Sciences

[Abstract] Results are presented from a study of the cyclical strength of a magnesium-based composite reinforced with high strength EP322 steel wire and boron filaments. The volumetric content of reinforcing fibers was 23 And 33% for the steel-reinforced composite, 20 and 33% for the boron-reinforced composite. Both materials were obtained by compressing unidirectionally reinforced monolayers at elevated temperatures, then cutting the specimens by the electric spark method. The results indicated high resistance to fatigue failure, the fibers acting as crack propagation barriers during cyclical loading. The steel fibers inhibited crack growth more strongly than the boron fibers, since both the fibers themselves and the boundary between the fibers and matrix had crack-stopping properties, but the steel fibers were more effective in stopping cracks than the boron fibers. Figures 4; references 7: 6 Russian, 1 Western.
[30-6508]

UDC: 621.762.4

THEORETICAL PRINCIPLES OF ROLLING OF METAL POWDERS

Moscow STAL' in Russian No 10, Oct 82 pp 75-77

VINOGRADOV, G. A., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] As powders are rolled the properties of the material change: the bulk body is converted to a rigid porous body with some compressive, tensile, flexural and shear strength. Due to the conservation of volume, during rolling of powders the sum of the logarithms of compaction of the material and of deformation in three mutually perpendicular directions is equal to zero. The most important angular parameters of the process of rolling of powders are studied. The process of rolling of metal powders can be divided into three periods: the initial unstable period, the stabilizing period and the final nonsteady period. The width of a rolled product significantly influences its thickness and density with unchanged setting of the rolls. Thickness increases with an increase in the total pressure on the rolls in proportion to the increase in the width of the strip. The basic parameters of the process of free gravitational rolling of metal powders are

noted, including the geometric parameters of roll diameter, product width and thickness and the physical-mechanical properties such as density, particle size distribution and chemical composition of the powders, shape and flow properties of the powder, rolling speed, viscosity of the gas medium in which rolling occurs, status of the roll surface, rigidity of the mill stand and rolling direction. Figures 3.
[24-6508]

UDC: 669.14.018:620.17

CRACK RESISTANCE OF PEARLITIC EUTECTOID STEELS, PART 1: FRACTURE OF STEELS UNDER SHORT TERM LOADING

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 18, No 4, Jul-Aug 82 (manuscript received 23 Feb 82) pp 42-48

ROMANIV, O. N., SHUR, Ye. A., TKACH, A. N., KISELEVA, T. N. and SIMIN'KOVICH, V. N., Institute of Physics and Mechanics imeni G. V. Karpenko, Ukrainian Academy of Sciences, Lvov; All-Union Scientific Research Institute of Rail Transport, Moscow

[Abstract] The main purpose of this work was to study the influence of shape and size of cementite particles as well as true austenitic grain size on the brittle fracture resistance of eutectoid steels with plate and granular pearlite steucture. Studies were performed on steels types 75G (0.75% C, 0.91 Mn, 0.20 Si, 0.18 Cr, 0.032 S, 0.027% P) and 75KhGST (0.74% C, 1.07 Mn, 0.51 Si, 1.03 Cr, 0.12 Ti, 0.018 S, 0.014% P). Specimens were heat treated in various manners to produce structures with cementite phase particles of different shapes and sizes, then annealed at 800, 1050 and 1250°C for 30 minutes and cooled with the furnace. The microstructure of the steels was studied with a scanning electron microscope after preliminary etching of the specimens. Tensile testing showed that dispersion of the cementite phase increases the strength characteristics of 75KhGST steel. The transition from granular to plate-like pearlite decreases ductility of steels without changing strength but also changes the nature of the influence of particle size of the cementite phase on ductility: in steels with spheroidized cementite as the carbide size is decreased ductility decreases, while in steels with plate-like pearlite it increases. The most unexpected result was the fact that decreasing the distance between plates or thickness of cementite plates, while causing $\sigma_{0.2}$ and σ_p to increase greatly, had very little influence on the fracture toughness. Figures 6; references 17: 7 Russian, 10 Western. [18-6508]

UDC: 539.2:681.32

ANISOTROPY OF ELASTIC PROPERTIES IN TITANIUM α-ALLOYS

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 82
(manuscript received 8 May 81) pp 105-108

ADAMESKU, R. A., ANDREYEVA, L. P., GEL'D, P. V., MITYUSHOV, Ye. A. and REYMER, N. D., Urals Polytechnical Institute, Sverdlovsk

[Abstract] A method is suggested for calculating Young's modulus in polycrystals with hexagonal close packed structure which does not have the limitations of previous methods in terms of type and nature of distribution of texture. The Young's modulus anisotropy in the alloys studied is determined primarily by the crystallographic texture, the significance of intergrain interactions being slight. The problem was solved by producing a calculation algorithm using two calculation systems--the Royce and Voigt systems--and numerical implementation of the method with automation of the entire computational process from the production of data on texture by means of high speed recording devices to the computation of material characteristics by digital computer. Figures 1; references 8: 5 Russian, 2 Western.
[14-6508]

UDC: 669.295:538.214:537.311.31

ROLLED PRODUCT TEXTURE AND ANISOTROPY OF ELASTIC PROPERTIES OF VT19 TITANIUM ALLOY

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNNAYA METALLURGIYA in Russian No 5, Sep-Oct 82 (manuscript received 28 Oct 81) pp 74-78

IVANIY, V. S., IVANIY, N. V. and KSHNYAKIN, V. S., Suma State Pedagogic Institute, Physics Department

[Abstract] Construction of three-dimensional orientation distribution functions is used to study the regularity of texture formation and anisotropy of elastic properties during cold rolling of commercial VT19 alloy. Measurement

of the anisotropy of Young's modulus in textured sheets and the orientation distribution function are used to estimate the compliance modulus of β-phase single crystals of the alloy in question. The initial VT19 4-mm strips were hardened from 750°C and contained the β-phase plus a small quantity of α-phase. Rolling was performed at room temperature in one direction on a mill with 140-mm-diameter rolls, reduction 10 to 90%. The compliance modulus values can be used to determine the elastic properties of polycrystalline alloys for various processes. Figures 2; references 11: 7 Russian, 4 Western.
[28-6508]

UDC: 621.791.052.08:669.295:66.014

DISTRIBUTION OF ALLOYING ELEMENTS IN WELDED JOINTS OF AT3 AND AT6 TITANIUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 82 pp 66-67

KOVAL', M. V., engineer, MELEKHOV, R. K., BLASHCHUK, V. Ye., candidates of technical sciences, and ONOPRIYENKO, L. M., engineer

[Abstract] A study was made of the distribution of aluminum, iron, chromium and silicon in the base metal and seam metal of welded joints in AT3 and AT6 alloys. The welded joints in the 20-mm-thick alloys were made by manual argon arc welding using a tungsten electrode with X-shaped separation of edges and 3-mm-diameter welding wire of SP2V alloy. It was found that the alpha phase in both alloys is distinguished by heterogeneity of composition: narrow and dark areas in comparison with broader light areas on the photographs obtained by absorption of electrons contain somewhat elevated quantities of aluminum, one-fourth the quantity of iron and two-fifths the quantity of chromium with practically the same quantity of silicon. The areas were so finely dispersed that it was impossible to analyze them separately in the seam metal. This segregation of aluminum, iron and chromium has a negative influence on the corrosion resistance of AT3 and AT6 alloy welded joints. Figures 2; references 5: all Russian.
[22-6508]

UDC 669.295:669.15'26'25-192

INFLUENCE OF TITANIUM ON MAGNETIC PROPERTIES AND STRUCTURE OF Fe-Cr-Co ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 10, Oct 82 pp 28-30

KOZLOV, Yu. I. and RAKITINA, Z. A., "Magnit" Production Association

[Abstract] A study is made of the possibility of increasing the coercive force of alloys containing 10 and 12% Co by increasing the quantity of titanium. The studies were performed on specimens measuring 16 x 16 x 55 mm obtained by casting in dry sand molds. The alloys were made of technically pure charge materials in open induction furnaces with magnesite crucibles. Heat treatment was performed by the following conditions: tempering from 1300°C in cold water, heating to 700°C, holding one hour, cooling from 700 to 580°C with the critical rate in a magnetic field of 200 kA/m, multistage tempering (620°C 1.5 hours, 600°C 2 hours, 580°C 3 hours, 560°C 4 hours, 540°C 10 hours). The results showed that as the concentration of cobalt decreases, the optimal content of titanium increases. Alloying with titanium can prevent the process of formation of the undesirable gamma phase. As titanium concentration increases the quantity of gamma phase decreases, as does the grain size. Alloys with 10 to 12% Co are superior in magnetic properties to all known low cobalt alloys of this class. The coercive force is sufficient at high values of maximum magnetic energy and residual induction. Titanium works by increasing the anisotropy of particles shaped in the highly magnetic α_1 phase. Figures 3; references 2: both Western.
[22-6508]

UDC: 539.43:669.715:620.191.33

INFLUENCE OF STRUCTURE OF VT3-1 ALLOY ON CYCLICAL CRACK RESISTANCE

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 18, No 4, Jul-Aug 82 (manuscriptireceived 6 Aug 80) pp 92-94

VASSERMAN, N. N., KATNOV, A. F., TOMSINSKIY, V. S. and SHISHKINA, M. I., Perm Polytechnical Institute

[Abstract] An estimate is presented of the cyclical crack resistance of VT3-1 alloy with varying structure based on results of testing of circular specimens in cantilever bending with rotation. The cracks on the specimens were preliminarily initiated, then their growth kinetics were studied. Specimens with globular and large grain plate-like structure were studied, cut from a bar 22 mm in diameter with initial globular structure. The plate-like structure was produced by heating the specimens to 1050°C for 1 hour and cooling them in air. Crack resistance characteristics determined included number of cycles required to generate a crack 1.5 mm in length with cyclical loading at 500 MPa,

number of cycles required for complete fracture of specimens with initial crack length 6 mm and stress intensity factors of 6.2 and 12.4 MPa/$\sqrt{m}$. Fracture toughness was also evaluated in extension of cylindrical specimens 12 mm in diameter with a circular crack. Evaluation of the cyclical crack resistance of VT3-1 with various structures indicated that for parts working under cyclical loading conditions the durability of which is limited primarily by the stage of crack propagation, a structure with plate-like α phase segregations is more desirable, while for parts whose durability is determined by the stage of fatigue crack generation, the spheroidal α phase form is preferable.
[18-6508]

UDC: 669.295:669.017.3

ON THE PRINCIPLES OF CONSTRUCTION OF TITANIUM ALLOY MICROSTRUCTURE SCALES

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 5, Sep-Oct 82 (manuscript received 28 Dec 80) pp 192-195

KOLACHEV, B. A., MAL'KOV, A. V. and GUS'KOVA, L. N., Moscow

[Abstract] The purpose of this work included objective classification of types of microstructures of titanium semifinished goods obtained by industrial technologies; determination of the qualitative relationships between the type of microstructure and properties of semifinished goods; determination of the structural components (for each type of microstructure), the status of which controls a given service property; establishment of quantitative relationships between structures and properties; and recommendation of a structural type with quantitative characteristics for products operating under certain conditions. A critical analysis is presented of the current standard scale of microstructure of semifinished goods and it is noted that the existing classification does not objectively reflect the relationship between the type of microstructure and service properties of the alloys. The possibility of changing mechanical and service properties by producing qualitatively and quantitatively regulated microstructure is demonstrated by using the VT6 $\alpha+\beta$ titanium alloy as an example. Figures 2; references 4: all Russian.
[12-6508]

UDC: 669.295'24'234:669.017.3

PHASE EQUILIBRIA AND CERTAIN PROPERTIES OF Ti-TiPd-TiNi SYSTEM ALLOYS AT 400°C

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 5, Sep-Oct 82 (manuscript received 17 Nov 81) pp 13-17

BORISKINA, N. G., KENINA, Ye. M. and TUMANOVA, T. A., Moscow

[Abstract] The Ti-TiPd-TiNi trinary system alloys were manufactured by induction melting in the suspended state in purified helium and annealed in stages at 900, 700 and 400°C for 7, 300 and 500 hours. An isothermic cross-section of the alloy at 400°C is presented, as well as photomicrographs of the microstructure of the alloys after annealing at 400°C. The addition of small quantities of nickel cannot increase the corrosion resistance of titanium in 20% HCl at 20 or 60°C. It is shown that 0.1 to 0.3% Pd increases the corrosion resistance of cast and particularly of annealed alloys. The addition of 0.2 to 0.3% Ni with 0.2% Pd increases the corrosion resistance of cast alloys in 20% HCl at 20°C and annealed specimens at 60°C. Figures 3; references 13: 8 Russian, 5Western.
[12-6508]

UDC: 669.295:539.67

HIGH TEMPERATURE INTERNAL FRICTION IN TECHNICAL TITANIUM

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 54, No 2, Aug 82 (manuscript received 17 Jul 81) pp 386-389

GRIDNEV, V. N. and KUSHNAREVA, N. P., Institute of Metal Physics, Unkrainian Academy of Sciences

[Abstract] A study is made of the temperature variation of internal friction in type VT1-0 technical titanium of the following composition (weight %): 0.07 C, 0.3 Fe, 0.1 Si, 0.2 O, 0.04 N, 0.010 H, 0.3 other elements, and type VT1-00: 0.05 C, 0.2 Fe, 0.08 Si, 0.1 O, 0.04 N, 0.008 N, 0.1 other elements. Measurements were performed by a low frequency method of pendulum torsion in a vacuum of at least $2 \cdot 10^{-3}$ Pa in the 20 to 1050°C temperature interval using specimens in the form of wires 1 mm in diameter (VT1-00) and specimens cut from sheets (both alloys). No significant qualitative differences were found in the shape of the curves of the sheet material specimens cut in different directions with respect to the direction of rolling. In the wire specimens the heating and cooling curves disagreed. T_{max} was greater and the δ_{max} less during heating than during cooling. The mechanism of suppression of the boundary peak is related to overcoming obstacles in shear deformation resulting from grain boundary dislocations within the limits of ordered grain sections. Measurements using more highly purified metals are desirable for final refinement of the boundary relaxation parameters in titanium.
Figures 2; references 12: 4 Russian, 8 Western.
[16-6508]

UDC: 621.771.23:669.295

INFLUENCE OF DEFORMATION CONDITIONS ON TEXTURE FORMATION AND DUCTILITY OF TITANIUM ALLOYS UNDER HYDROSTATIC PRESSURE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 54, No 2, Agu 82 (manuscript received 12 Jun 81) pp 370-373

DEKUN, A. M., KUSHAKEVICH, S. A., ADAMESKU, R. A., KHMELININ, Yu. F., BERESNEV, B. I. and SHISHMINTSEV, V. F., Metal Working Plant imeni V. I. Lenin, Verkhnesaldinskiy Rayon

[Abstract] A study is made of the influence of crystallographic orientation, grain size and high hydrostatic pressure on pressed bars of titanium alloys. The studies were performed on bars of VT1-0 and VT5-1 (α-alloys) and VT3-1 ($\alpha+\beta$ alloy). The bars were deformed by hot pressing with drawing factors of 3.4, 13.4 and 37.3 with the pieces heated to the α, $\alpha+\beta$ and β areas. The temperatures, degree of deformation and type of structure produced had little influence on the mechanical properties of the bars in the hot pressed state. Heterogeneity of the texture was greatest in the α alloy bars. Application of hydrostatic pressure during tensile testing of specimens increases their ductility. Figures 2; references 6: 5 Russian, 1 Western.
[16-6508]

UDC: 669.295.5:669-131.4:548.4:620.187.3

DISLOCATION STRUCTURE AFTER HOT DEFORMATION OF VT22 HIGH TITANIUM ALLOY

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 54, No 2, Aug 82 (manuscript received 14 Jul 80, in final form 3 Jul 81) pp 339-346

NOTKIN, A. B., PERTSOVSKIY, N. Z., POL'KIN, I. S., SEMENOVA, N. M. and YEFIMOVA, M. V.

[Abstract] The method of diffraction electron microscopy is used to conduct a systematic study of the influence of temperature and degree of deformation, as well as structure of the individual blank, on the dislocation structure of a β solid solution of VT22 alloy. The data obtained are used to estimate the influence of these factors on the mechanical properties of the alloy. The studies were performed on specimens of the following composition in weight %: Ti+5Al+4.8Mo+4.7V+1Cr+1Fe. Specimens measuring 8 x 8 x 10 mm were deformed by upsetting under near isothermal conditions at $5 \cdot 10\ s^{-1}$. Subgrain dimensions were measured by random sections. Photomicrographs are presented. In specimens with initial recrystallized structure and slight deformation, extended subgrains with 1 to 1.5° disorientation are formed in the β solid solution. Increasing the degree of deformation leads to formation of subgrains of uniform axis, reduced grain size and increased disorientation of up to 3 to 5° or more. The formation of a large grain recrystallization

structure or polygonization structure results in lower plasticity. Overall ductility can be increased by using a blank with initial polygonized structure. Figures 4; references 10: 9 Russian, 1 Western.
[16-6508]

UDC: 669.295.5.017

STRUCTURE OF ALPHA PHASE IN TWO-PHASE TITANIUM ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 54, No 2, Aug 82 (manuscript received 28 Jul 81) pp 302-306

GRIDNEV, V. N., IVASISHIN, O. M. and SVECHNIKOV, V. L., Institute of Metal Physics, Ukrainian Academy of Sciences

[Abstract] The specifics of the structural state of the residual alpha phase arising as a result of partial $\alpha+\beta$ to β conversion and subsequent cooling are studied. The work is performed on VT6 and VT23 alloys with varying degrees of alpha phase aluminum alloying - 6.2 and 4.1%. The initial state of the alloys was formed by beta annealing. The temperature intervals of phase conversion in the process of heating and cooling were determined by thermoresistometric analysis. The heating temperature and cooling rate were selected so as to avoid conversion of the metastable beta phase upon cooling. The basic method of the study was transmission electron microscopy. Photomicrographs are presented. The studies performed indicate that partial $\alpha+\beta$ to β conversion and subsequent cooling causes significant changes to the structure of the residual alpha phase determined by its initial morphology and chemical composition. These changes doubtless have an influence on the properties of the alloys studied as on their behavior in further heat treatment. Figures 5; references 8: 1 Russian, 7 Western.
[16-6508]

UDC: 621.791.052.08:620.179.16(047)

ACOUSTICAL DIAGNOSIS OF LOAD-BEARING CAPACITY OF WELDED STRUCTURES

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 82
(manuscript received 28 May 82) pp 1-8

PATON, B. Ye., academician, NEDOSEKA, A. Ya., doctor of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences

[Abstract] A survey is presented of experience in the application of acoustical testing of the load-bearing capacity of welded structures, particularly as applies to assurance of safety of the operation of nuclear powerplants as they increase in both power capacity and number. Limited information is given on the use of acoustical emission for welded joint strength testing in the socialist countries, including some work done in Czechoslavakia using American equipment. Analysis of the literature of both the USSR and other nations indicates that a good deal of experience has been accumulated in the defectoscopy of products, in which acoustical systems can detect and indicate the location of increased acoustical activity of materials to locate defects which can be then verified by other methods of testing. Figures 5; references 28: 15 Russian, 13 Western.
[22-6508]

UDC: 621.791.052.08:620.179.16.002.5

SPECIALIZED APPARATUS FOR MULTICHANNEL ACOUSTICAL-EMISSION MEASUREMENT AUTOMATION SYSTEMS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 82
(manuscript received 11 Jun 82) pp 13-18

TARARAKSIN, S. A. and YAKOVLEV, G. V., engineers, Institute of Atomic Energy imeni I. V. Kurchatov

[Abstract] The Institute of Atomic Energy imeni I. V. Kurchatov has created a hardware system for the development of universal research measurement

multichannel systems which can be used to develop acoustical emission methods for observation of the integrity of reactor bodies and first loop equipment at nuclear powerplants. The system has been developed using the KAMAK state standards, is modular in design, program controlled and allows use of the entire assortment of available modules including so-called systems modules. One possible configuration is diagrammed and d scribed. The interaction of the primary units in the hardware and operating conditions are described. Using this hardware, the Institute of Atomic Energy imeni I. V. Kurchatov has composed an acoustical emission system including a YeS-1010 computer which has been used for a number of acoustical emission measurements during hydraulic pressure testing of large objects. The results indicate good functional capability of the apparatus.
[22-6508]

UDC: 621.791.052.08:620.179.16:62-462-181.2

USING METHOD OF ACOUSTICAL EMISSION TO ESTIMATE LARGE DIAMETER PIPE QUALITY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 82
(manuscript received 21 Feb 82) pp 45-48

TROITSKIY, V. A., doctor of technical sciences, and DONIN, A. R.,,engineer
Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences

[Abstract] Ultrasonic testing reveals longitudinal cracks rather well, in contrast to x-ray television testing. Transverse cracks are poorly revealed by both methods. To eliminate this shortcoming, a combined system of testing should include acoustical emission testing, which can rather reliably determine cracks developing in welded joints regardless of their orientation. A cycle of studies was performed in 1979-1980 at the Khartsyzsk pipe plant to determine the possibility of using AE to test pipes and select the place in the process line where acoustical emission testing would be most effective. The best results were obtained when AE signals were studied which were radiated during cooling of welded joints in the pipes. Best of all is testing after welding of the second outer seam of the four seams (two inner, two outer) used in all. There was a noticeable correlation between the number of growing cracks and AE signal parameters. In an area with three cracks, acoustical emission continued for more than 10 minutes; the signals had significant amplitude and their total number was over 70,000. In areas with one crack, emission lasted about 5 minutes; the signals were less frequent and their total number was 20,000 to 30,000. Figures 4; references 3: all Russian.
[22-6508]

UDC: 621.791.052.08:621.643-408.3:620.179.16

DIAGNOSIS OF TECHNICAL CONDITION OF WELDED CLAD PIPES USING ACOUSTICAL EMISSION

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 82
(manuscript received 21 May 82) pp 9-12

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[Abstract] A study is made of certain results of defectoscopic testing of natural pipe sections using methods of acoustical emission. Testing was performed to evaluate structural strength and study the influence of technological welded joint defects and artificial notch defects in welded seams and in the base metal on structural strength. Pipe sections with outside diameter 836 mm, wall thickness 40 mm, length 1600 mm were prepared of two half shells of 22 K clad sheet steel joined with a longitudinal seam made by automatic welding, then tempered at 300°C for 7 hours, 635°C 5 hours and 10 minutes, cooling with the furnace at 300°C, then cooling in air. The pipes were tested with repeated static internal pressure loading. The test program included initiation of cracks from notches, repeated static loading with pressure to establish the variation of crack growth rate as a function of applied loads. Recording of acoustical emissions can produce more complete and well-founded information for evaluation of the technical status and workability of structures than data on equivalent defect size obtained by ultrasonic testing alone. Figures 8; references 3: all Russian. [22-6508]

UDC: 621.791.052.08:620.179.16:539.3:51.001.57

SOME MATHEMATICAL MODELS OF SOURCE OF ACOUSTICAL EMISSION IN ELASTIC WELDED STRUCTURES

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 82
(manuscript received 21 May 82) pp 19-21, 30

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[Abstract] Several approaches are suggested to theoretical analysis of wave formation upon excitation of acoustical emission in elastic bodies. Acoustical emission is caused by local disruptions of the continuity of a medium. The surface energy liberated in this process is transfered in the form of volumetric and/or surface waves to the observer. The time of arrival of the leading edges of an echosignal returning to a radiator or early interruption of probing of a remote point can be used to determine the moment

of development of a discontinuity and its distance from the probe. Acoustical emission in welded structures is a complex process, requiring that mathematical modeling be performed in stages as a function of the specific task at hand, moving from simple problems to more complex ones. A comprehensive study will be possible only within the framework of the systems approach. References 12: 9 Russian, 3 Western.
[22-6508]

UDC: 621.791.052.08:620.179.16:669.715

VARIATION OF ACOUSTICAL EMISSION SIGNALS AS FUNCTION OF NATURE OF WELDING DEFECT IN AMg6M ALLOY

Kiev AVTOMATICHESKAYA SVARKA in Russian No 9, Sep 82
(manuscript received 25 May 82) pp 36-38, 48

TIKHIY, V. G., candidate of technical sciences, SANIN, F. P., doctor of technical sciences, BORSHCHEVSKAYA, D. G., candidate of physical-mathematical sciences, BIGUS, G. A., EVINA, T. Ya. and BARANOVSKAYA, T. F., engineers, Dnepropetrovsk

[Abstract] One promising method of diagnosing the quality of welded joints is the method of acoustical emissions, based on the radiation of elastic stress waves upon deformation of a material. This work attempts to establish the variation of the nature of AE signals as a function of the type of welded defects in AMg6M alloy. A standard control was used based on comparing the parameters of acoustical emission signals upon loading of defective welded joint specimens and defect-free specimens, as well as the base material. Specimens of AMg6M sheet material 6 mm thick and its welded joints made according to the state standards were used in the test. It was demonstrated that it is possible to establish a correlation between the nature of an AE signal and the type of defect in welded joints in this material. The acoustic diagrams obtained allow identification of the source of the acoustic emission. Batches of pulses of low intensity, as well as single pulses of large amplitude against the background of intensive low frequency noise, indicate that the source of AE is a zone of plastic deformation of the material. Emission signals consisting of individual high amplitude pulses are the result of discrete movements of microscopic cracks. High energy, high intensity signals, can be explained by the influence of nonmetallic inclusions. Figures 5; references 11: 10 Russian, 1 Western.
[22-6508]

UDC: 621.791.72

WELDING OF LOW ALLOY AND CORROSION RESISTANT STEELS BY BEAM OF LIGHT IN NITROGEN

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 10, Oct 82 pp 9-11

NIKIFOROV, G. D., doctor of technical sciences, FEDOROV, S. A., candidate of technical sciences, OVCHINNIKOV, V. V., engineer, Institute of Aviation Technology imeni K. E. Tsiolkovskiy, Moscow

[Abstract] Heating by a beam of light involves contactless application of energy to a product, negligible mechanical effect of the source on the welding bath and great controllability of heat input to the product. Nitrogen is practically transparent light and therefore intensive saturation of the metal with the gas does not occur when it is the medium in which welding by light is performed. Experiments involving welding of plates 0.5 to 1.0 mm thick of St3 and 12Kh18N10T steel were performed on an experimental USS-1 installation including a xenon arc lamp type DKsR-5000-1 rated at 5 kW, with an ellipsoidal reflector concentrator 358 mm in diameter. The specimens were preliminarily degreased, then welded in a clamp under near nominal operating conditions for the lamp, welding rate 5 to 20 m/hr. Tensile testing was performed. The mechanical properties of the joints produced in nitrogen and argon were found to be identical. The study of the process of formation of the welding bath showed that a good seam was formed when oxygen was present as an impurity. Figures 3; references 3: all Russian. [25-6508]

UDC: 669.018.6:548.7

INFLUENCE OF WEIGHTLESSNESS ON STRUCTURE AND PROPERTIES OF ALLOYS WITH SINGULAR PHYSICAL PROPERTIES

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 5, Sep-Oct 82 (manuscript received 25 May 82) pp 24-32

SAVITSKIY, Ye. M., MIKHAYLOV, B. P., BYCHKOVA, M. I. and TORCHINOVA, R. S., Moscow

[Abstract] During technological experiments on board the Salyut-6 space craft and high altitude rockets the materials tested were selected primarily to conform to the heating parameters of the furnaces used as well as to answer the most interesting questions of the metallurgy of weightlessness. Mo-Ga alloys are interesting because they have two superconducting compounds. including Mo_3Ga with a critical point of 14°K. Experiments on the synthesis of superconducting Nb_3Sn and V_3Ga under weightless conditions were performed due to their very high critical points of about 18.0 and 16.0°K. A superconducting eutectic alloy of Pb+Sn was crystallized under weightless conditions to establish certain regularities of the influence of weightlessness on phase formation in eutectic alloys and on the superconducting critical current. Photomicrographs of the microstructure and photographs of the macrostructure of specimens produced under weightless conditions are presented. The experiments show convincingly the possibility of using the factor of weightlessness to improve the properties of these materials. The information produced in this stage represents the first bit of knowledge concerning a completely new direction in the development of metallurgy. Figures 9; references 9: 5 Russian, 4 Western.
[12-6508]

UDC: 669.046.55.067

NEW METHOD AND EFFECTIVENESS INDICES OF SLAG REFINING OF METAL

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 8, Aug 82 (manuscript received 17 Feb 82) pp 7-10

SHAKIROV, K. M., Siberian Metallurgical Institute

[Abstract] A study is made of a new method of refining which has the advantages and to a large extent eliminates the disadvantages of known methods using slag melts. It is based on simultaneous dispersion of both phases upon collision of oppositely directed jets of liquid metal and slag. The jets of metal and slag flow from nozzles oriented horizontally, collide, and form a two-layer disk of a certain radius in which the metal and slag move continuously outward from the center in the form of thin films. When the films reach a certain thinness at the edge of the disk they break up into 2-phase drops which separate into the initial phases as they fall through the bath below the two jets, leaving the slag on top and the metal on bottom. The dimensionless indices of effectiveness of refining of the metal as a function of dimensionless phase contact time are computed for the synthetic slags used in the process. Figures 2; references 2: both Russian.
[20-6508]

UDC: 669.24:621.785.79:620.18

INFLUENCE OF HAFNIUM, ZIRCONIUM AND RHENIUM ON STABILITY OF CAST REFRACTORY ALLOY STRUCTURE

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA in Russian No 8, Aug 82 (manuscript received 12 Oct 81) pp 66-70

NAGIN, A. S. and GADALOV, V. N., Komsomolskiy-na-Amure Polytechnical Institute

[Abstract] An attempt is made to form the optimal microstructure and achieve its stability by alloying heat resistant alloys with active elements: hafnium, zirconium or rhenium. The studies involved cast heat resistant nickel-chromium-based alloys containing 5% Mo, 9% Fe, 4.2% (Al+Ti), 0.05% C, melted in a vacuum induction furnace with a magnesite curcible. Combined studies of the phase composition showed that the introduction of small quantities of hafnium, zirconium and rhenium helped to form more stable primary carbide phases. Alloying with these active additives results in a decrease in grain boundary peak height, indicating hardening of the intergrain space, provided both by dispersion of the carbide phases and by increasing the thermodynamic stability of the eutectic structures filling the intergrain spaces. This increases the solidus temperature and inhibits processes of diffusion and fracture along grain boundaries. Figures 2; references 16: 14 Russian, 2 Western.
[20-6508]

UDC: 669.721:548.4:620.187.3

DIPOLE STRUCTURES FORMED IN MAGNESIUM UPON BASE SLIPPING

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 54, No 2, Aug 82 (manuscript received 30 Jul 81) pp 347-352

ATTA, A., BLAGOVESHCHENSKIY, V. V., ZINENKOVA, G. M. and TYAPUNINA, N. A., Moscow State University

[Abstract] A study is presented of dipoles in Mg using transmission electron microscopy. It is concluded that upon base slipping dipole structures are formed in Mg of mixed dislocations with opposite Burger's vectors and Burger's vectors at an angle of 120° to each other. Calculations show that the formation of dipoles of mixed dislocations is energetically favorable. With arbitrary α they are stable dipole configurations with δ = 180°C and with δ = 120°. Figures 4; references 9: 4 Russian, 5 Western. [16-6508]

UDC: 669.721.5:669.018.44

PRINCIPLES OF ALLOYING HEAT RESISTANT MAGNESIUM-BASED ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 5, Sep-Oct 82 (manuscript received 2 Apr 82) pp 98-103

DRITS, M. Ye., ROKHLIN, L. L., ORESHKINA, A. A. and NIKITINA, N. I., Moscow

[Abstract] Studies of the structure of heat resistant magnesium alloys were performed showing that the hardening phase crystals which precipitate upon decomposition of the supersaturated solid solution are located primarily at the grain boundaries and other crystalline lattice imperfections which develop in the process of deformation of the alloys. This creates obstacles for processes related to movement of dislocations at elevated temperatures and increases the resistance to plastic deformation. A table is presented of binary magnesium alloy systems in which limited solid solutions based on magnesium are formed. The studies performed confirmed that in magnesium alloys with rare earth metals and thorium the best properties are achieved at elevated temperatures. These elements have significant solubility in solid magnesium. The composition of the hardening phases in the alloys should include large quantities of magnesium. The hardening phases must melt at high temperatures. Figures 3; references 9: 8 Russian, 1 Western. [12-6508]

UDC: 539.385:669.721.5

INFLUENCE OF VACUUM AND LOW TEMPERATURE ON FATIGUE CRACK GROWTH RATE IN MAGNESIUM ALLOY SHEETS

Kiev FIZIKO-KHIMICHESKAYA MEKHANIKA MATERIALOV in Russian Vol 18, No 4, Jul-Aug 82 (manuscript received 19 Mar 81) pp 48-54

GRINBERG, N. M., SERDYUK, V. A., MALINKINA, T. I. and KAMYSHKOV, A. S., Low Temperature Physics and Engineering Institute, Ukrainian Academy of Sciences, Kharkov

[Abstract] This work studies the growth rate of penetrating and non-penetrating fatigue cracks in magnesium alloys differing in composition and heat treatment over a broad range of change of stress intensity factor in a vacuum and at low temperature. Study of the combined effect of these factors is also of interest because in low temperature testing in cryogenic fluids the influence of the medium is usually not considered, though it is quite great. The objects studied were 6 magnesium alloys: MA2-1, MA15, IMV6, MA12, MA21 and VMD10. Alloy VMD10 (7% Y, 1.85 An, 1.73 Cd, 0.5% Zr, remainder Mg) and IMV6 were studied in the hot rolled state without subsequent heat treatment. Trapezoidal specimens were used with a semicircular lateral notch made of heat treated sheets following mechanical and electrolytic polishing. Loading was by cyclical symmetrical cantilever flexure at 12.5 Hz. It was found that vacuum helps to decrease the growth rate of both surface and penetrating fatigue cracks in all of the alloys studied. The threshold and critical stress intensity factors did not vary as a function of ambient medium. The micromechanism of fracture in a vacuum is more viscous than in air. Decreasing the temperature has a varying influence on crack growth rate. At low K_{max} it decreases at low temperatures. With high K_{max}, crack growth may either slow down or intensify depending on alloy composition and structural state. The threshold value increases with decreasing temperature, the critical value is determined by the microstructure of the alloys. Figures 4; references 8: 7 Russian, 1 Western.
[18-6508]

UDC: 669.14.018.853:669.794'854'297

RARE ELEMENT ALLOYING FOR IMPROVEMENT OF PROPERTIES OF HEAT RESISTANT NICKEL ALLOYS

Moscow STAL' in Russian No 10, Oct 82 pp 61-66

SUDAKOV, V. S., KLYUYEV, M. M., FILATOVA, M. A., TSVETKOVA, V. K. and BARABANOV, S. P., "TSNIITmash" Scientific-Production Association and "Elektrostal'" Plant

[Abstract] The purpose of this work is to study the influence of hafnium, yttrium and lanthanum (individually and in combination) on the structure and

properties of deformed heat-resistant KhN65KVMYuTB alloy. Experimental melts were produced in an open 36-kg induction furnace with a magnesite crucible. The rare elements were added on a bar to the aluminum-deoxidized melt 2 to 3 minutes before tapping of the furnace. Ingots 100 mm in diameter were pressed into two 44-mm-diameter bars. The alloys were heat treated by heating to 1150°C, holding 3 hours, cooling in air plus heating to 800°C, holding 20 hours, cooling in air. Addition of 0.65% Y resulted in its maximum loss. Hafnium and lanthanum were assimilated to over 70%. All the rare earth elements reduced the gamma solid solution grain size. Combined additives increased the content of oxide nonmetallic inclusions. The strengthening gamma' phase in all alloys had a near spherical shape, its dimensions depending on the concentration and composition of the additives. The most finely dispersed gamma' phase was noted in alloys with 1.0% Hf and 0.25% La. Electron fractographic studies showed that alloying with rare earth elements significantly changes the carbide phase morphology. Photomicrographs are presented. Alloying with yttrium resulted in reduced impact toughness. Long-term strength and ductility increased simultaneously with the addition of 1.0% Hf. Additions of 0.25% La or a combination of 0.40% Hf plus 0.25% Y plus 0.40% La improved long-term strength but decreased long-term ductility, and have a favorable influence on heat resistance. Figures 6; references 15: 12 Russian, 3 Western.
[24-6508]

UDC: 539.4

LONG-TERM FRACTURE OF EI607A STRUCTURAL ALLOY IN PLANAR STRESS STATE

Kiev PROBLEMY PROCHNOSTI in Russian No 9, Sep 82
(manuscript received 25 Dec 81) pp 39-41

PAVLOV, P. A. and BRONZ, V. Kh., Leningrad Polytechnical Institute

[Abstract] A study is made of the fracture of EI607A nickel-based heat resistant structural alloy in a planar stress state with unsteady loading. The experimental portion of the work was performed on a device allowing testing of thinwall tubular specimens under simultaneous extension and torsion. The tensile force and torque could be varied as desired with loading modes assigned in true stresses related to the actual dimensions for each moment of testing, while the moment of deformation consisted of the components of the true deformation tensor. All tests were performed at 700°C. An equation is derived to describe the long-term failures occurring under the experimental conditions. Figures 1; references 5: all Russian.
[14-6508]

UDC: 669.285

MECHANICAL AND TECHNOLOGICAL PROPERTIES OF VACUUM SMELTED MOLYBDENUM-TITANIUM ALLOY SHEETS

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNNAYA METALLURGIYA in Russian No 5, Sep-Oct 82 (manuscript received 21 Oct 81) pp 78-81

ARBUZOV, V. K., ZAKHAROV, A. M., ALYUSHIN, K. Ye. and NAZAROVA, L. V., Moscow Institute of Steels and Alloys, Department of Nonferrous, Rare and Radioactive Metal Science

[Abstract] Forty-kg ingots were produced in a vacuum arc furnace with a 115-mm-diameter crystallizer. The alloys contained 0.06, 0.11, 0.19 and 0.24% Ti and 0.013-0.018% C, gas impurity content not over 0.004% O, 0.003% N and 0.0004% H. Hot pressing was used to produce blanks for hot and warm rolling, then sheets (after annealing for stress relief and etching) were cold rolled to 0.5-mm thickness. The mechanical properties of the sheets were determined at room temperature by tensile testing of specimens 10 x x 100 mm cut at an angle of 45° and 90° to the direction of rolling; closed impression die forging capacity was determined in depression depth testing. A significant drop in tensile strength in the direction of rolling was observed after annealing at 900 to 1150°C. Annealing of cold rolled sheets before stamping maximizes stress relief but should not cause primary crystallization. The greatest strength and least ductility were observed in specimens cut transverse to the direction of rolling. The best combination of ductility and capacity for stamping after subrecrystallization annealing at a temperature 50°C below the recrystallization point was observed in sheets containing 0.11% Ti. Figures 3; references 9: all Russian. [28-6508]

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